**UNITED STATES DISTRICT COURT**
**FOR THE WESTERN DISTRICT OF TEXAS**
**WACO DIVISION**

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|---|---|---|
| TC TECHNOLOGY LLC,<br><br>Plaintiff,<br><br>v.<br><br>T-MOBILE USA, INC.,<br><br>Defendant. | ) | C.A. No. 6:20-cv-899<br><br>**JURY TRIAL DEMANDED** |

## COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff TC Technology LLC ("TC Technology"), by and through its attorneys, and for its Complaint against Defendant T-Mobile USA, Inc. ("T-Mobile") alleges as follows:

## NATURE OF THE ACTION

1. TC Technology brings this action against T-Mobile for infringement of U.S. Patent No. 5,815,488.

## THE PARTIES

2. TC Technology is a limited liability company organized and existing under the laws of the State of Delaware with a principal place of business located at 12405 Powerscourt Drive, St. Louis, Missouri 63131.

3. T-Mobile is a corporation organized and existing under the laws of the State of Delaware with a principal place of business located at 12920 SE 38th Street, Bellevue, Washington 98006. T-Mobile may be served through its registered agent Corporation Service Company, with

a business address of 211 E. 7th Street, Suite 620, Austin, Texas 78701. On information and belief, T-Mobile is registered to do business in the State of Texas and has been since at least November 22, 1999.

## THE LTE STANDARD

4. Long Term Evolution ("LTE") is a standard for wireless broadband communication for mobile devices and data terminals developed by the 3rd Generation Partnership Project ("3GPP"). Any LTE digital cellular standards as defined by the 3GPP (including the frequency division duplex (FDD) and time division duplex (TDD) variants) and all evolutions and subsequent versions of those standards are referred to in this Complaint as the "LTE Standard."

5. 3GPP is a standard setting organization that creates technical specifications, which companies can adopt to ensure that their products are compatible with others' products in the telecommunications industry.

6. LTE is an evolution of the Universal Mobile Telecommunications Service (UMTS), which is a third-generation (3G) mobile cellular standard also set by the 3GPP. Compared to 3G, LTE delivers mobile communications network at a higher capacity and higher speed.

7. LTE was first released in December 2008 as part of 3GPP Release 8, and has continued to evolve to provide more features and improvements. For instance, in March 2011, LTE-Advanced was introduced in Release 10, allowing 1 Gbps download and 500 Mbps uplink throughput; and in March 2016, LTE-Advanced Pro was introduced in Release 13, providing further performance improvements with enhancements to technologies such as carrier aggregation and MIMO (Multiple Input Multiple Output).

## U.S. PATENT NO. 5,815,488

8. TC Technology owns by assignment the right, title and interest in United States Patent No. 5,815,488 ("the '488 patent"), titled "Multiple User Access Method Using OFDM," which issued on September 29, 1998, naming Thomas H. Williams and Richard S. Prodan as co-inventors. A true and correct copy of the '488 patent is attached to this Complaint as Exhibit 1.

9. The '488 patent relates to fundamental innovation in LTE communication that permits multiple users of mobile devices to simultaneously access an RF channel with a high degree of immunity to channel impairments.

## ACCUSED SERVICES

10. Upon information and belief, T-Mobile used, sold, and offered to sell communication services with LTE capabilities (the "Accused Services"), including but not limited to cellular data services, cellular voice services, and texting services compliant with the LTE Standard, in the Western District of Texas and throughout the United States.

11. T-Mobile owns and operates an LTE network in the Western District of Texas and elsewhere in the United States. T-Mobile advertised its LTE network's breadth of coverage on its website, including its 4G LTE coverage in seventeen different cities in the State of Texas, including those in the Western District of Texas.[1] T-Mobile also advertised itself as having "the fastest nationwide 4G LTE speeds."[2]

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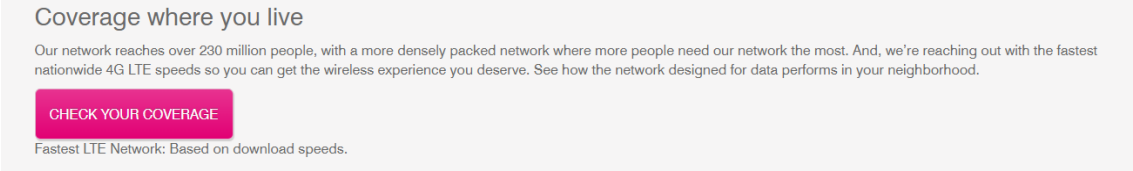
[1] *See, e.g.*, https://web.archive.org/web/20140717165808/http://t-mobile-coverage.t-mobile.com/4gcitylist.aspx. An archived copy of this website is attached to this Complaint as Exhibit 2.

[2] *See, e.g.*, https://web.archive.org/web/20141216110541/http://explore.t-mobile.com/4g-lte-network#datastrong. An archived copy of this website is attached to this Complaint as Exhibit 3.




12. T-Mobile provided services for use on its LTE network. T-Mobile offered to sell and sold a variety of voice, text, and data products and services for use with the T-Mobile LTE network. For example, T-Mobile offered to sell and sold an array of plans all offering one gigabyte or more of 4G LTE data on T-Mobile's 4G LTE network.[3]


[3] *See, e.g.*, https://web.archive.org/web/20141202030322/http://www.t-mobile.com/cell-phone-plans/individual.html.

13. T-Mobile made its voice, data, and text services available to its customers, who used the services at the direction or control of T-Mobile. T-Mobile conducted business operations within the Western District of Texas in several stores and facilities throughout the District.[4]

14. On information and belief, T-Mobile employees and contractors test T-Mobile's voice, data, and text services.

15. Customers were required to agree to T-Mobile's Terms and Conditions before accessing T-Mobile's LTE network. T-Mobile provided a copy of its Terms and Conditions on its website.[5]

> Your agreement with "T-Mobile" (defined as T-Mobile USA, Inc., and its controlled subsidiaries, assignees, and agents) includes these Terms and Conditions ("T&Cs"), your Service Agreement, applicable supplemental terms and conditions, and your Rate Plan terms, which are available at www.T-Mobile.com (collectively "Agreement"). Your Rate Plan includes your Service allotments for minutes, messages or data ("Allotments"), rates, coverage and other terms ("Rate Plan"). To the extent any term in your Rate Plan expressly conflicts with these T&Cs, the term in your Rate Plan will govern. **Your Agreement applies to each line of Service, although different T&Cs may apply to different lines of Service on your account.**

16. The use of these services that T-Mobile provided to its customers and employees on T-Mobile's LTE network resulted in infringement of the '488 patent.

## JURISDICTION AND VENUE

17. TC Technology realleges, adopts, and incorporates by reference the allegations contained in paragraphs 1-16 above as if fully set forth in this paragraph.

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[4] *See, e.g.,* https://www.yelp.com/biz/t-mobile-austin-13; https://www.yelp.com/biz/t-mobile-austin-7; https://www.yelp.com/biz/t-mobile-waco-2. Copies of these websites are attached to this Complaint as Exhibits 4, 5, and 6.

[5] https://www.t-mobile.com/responsibility/legal/terms-and-conditions-nov-2014

18. This is a civil action for patent infringement arising under the patent laws of the United States, 35 U.S.C. § 1 *et seq*.

19. This Court has subject matter jurisdiction over the matters asserted in this Complaint under 28 U.S.C. §§ 1331 and 1338(a) and 35 U.S.C. §§ 271 *et seq*.

20. This Court has personal jurisdiction over T-Mobile, because T-Mobile conducts continuous and systematic business in this District, including by its use, sale, and offer of the Accused Services to the residents of the Western District of Texas that T-Mobile knew would be used within this District, and by soliciting business from the residents of the Western District of Texas. For example, T-Mobile is subject to personal jurisdiction in this Court, because T-Mobile has regular and established places of business at its stores in the Western District of Texas, and elsewhere in the State of Texas, and directly and through agents regularly conducts, solicits, and transacts business in the Western District of Texas and elsewhere in the State of Texas.[6]

21. In particular, T-Mobile has committed acts of infringement in violation of 35 U.S.C. § 271, and has used, sold, and offered to sell the Accused Services in the State of Texas, including in this District, and engaged in infringing conduct within and directed at or from this District. For example, T-Mobile has purposefully and voluntarily placed the Accused Services into the stream of commerce with the expectation that those Accused Services would be used in this District.

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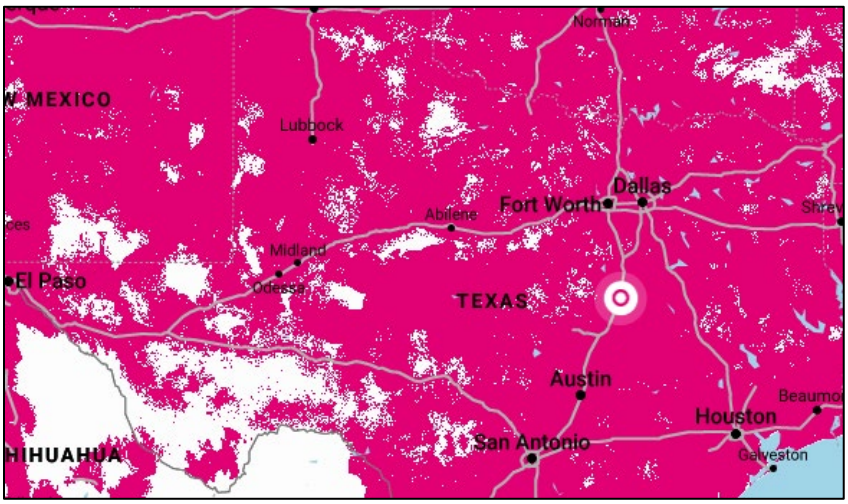
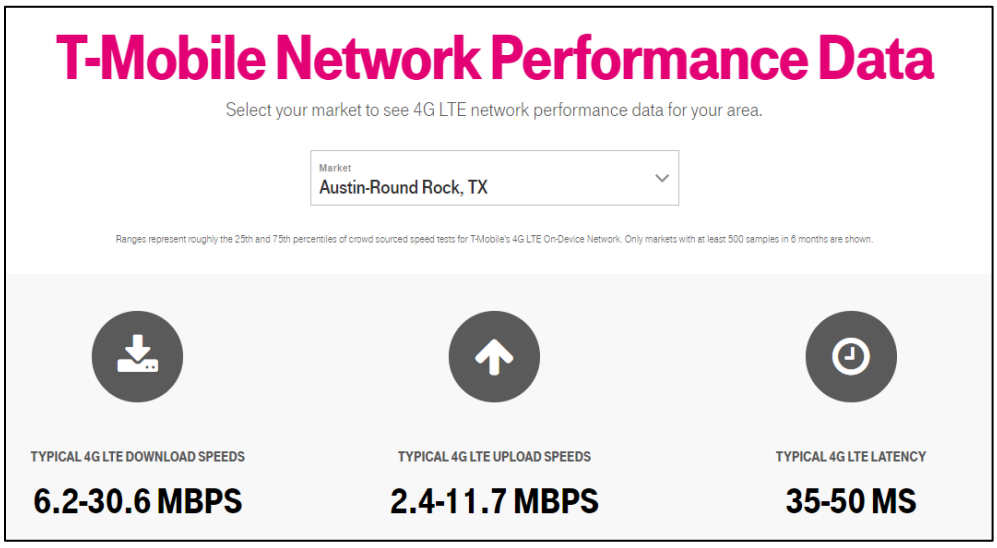
[6] https://www.t-mobile.com/store-locator?sortBy=type2&page=1&search=austin,%20TX; https://www.t-mobile.com/store-locator?sortBy=type2&page=1&search=Waco,%20TX,%20USA. Copies of these websites are attached to this Complaint as Exhibits 7 and 8.

22. In particular, T-Mobile conducts a significant amount of business in the State of Texas based on its LTE network. For example, coverage maps available on T-Mobile's website show that its services are available on its 4G LTE network throughout the State of Texas.[7]

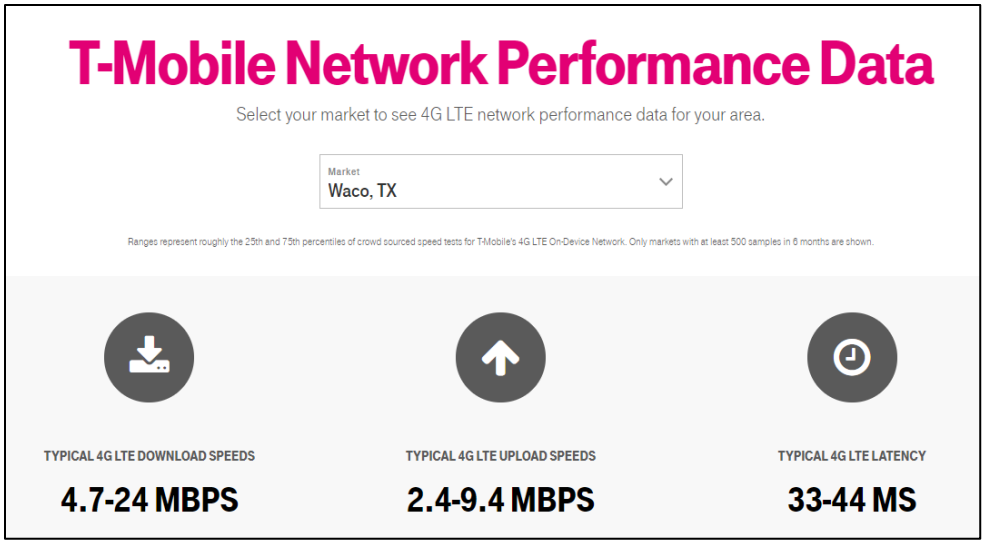



23. T-Mobile also advertises the speed and performance of its LTE network in multiple cities within the Western District of Texas.[8]




[7] https://www.t-mobile.com/coverage/coverage-map?icid=WMM_TM_U_19NETWORK_8NJ75N1T1380WNW518566

[8] https://www.t-mobile.com/coverage/network-performance-data




24. T-Mobile also conducts a significant amount of business throughout the Western District of Texas through its offers to sell, sales, and leases of consumer devices for use with its services.

25. As described in paragraphs 10-16, T-Mobile provided services to its employees and customers for use on T-Mobile's LTE network in the State of Texas and elsewhere in the United States.

26. The Accused Services have been made available in, distributed to, and used in this District. T-Mobile's infringing acts caused injury to TC Technology, including within this District.

27. Venue is proper in this District under the provisions of 28 U.S.C. §§ 1391 and 1400(b) at least because a substantial part of the events or omissions giving rise to the claims occurred in this District, and because T-Mobile has committed acts of infringement in this District and has a regular and established place of business in this District. In particular, T-Mobile has regular and established places of business at its stores in this District (*see* paragraphs 13 and 20 above, which are incorporated by reference in this paragraph). On information and belief, T-

Mobile employs engineers, salespeople, and/or other personnel within this District, including personnel familiar with the operation and distribution of the Accused Services.[9]

**COUNT 1: INFRINGEMENT OF U.S. PATENT NO. 5,815,488**

28. TC Technology realleges, adopts, and incorporates by reference the allegations contained in paragraphs 1-27 above as if fully set forth in this paragraph.

29. As the owner of the '488 patent, TC Technology is authorized and has standing to bring legal action to enforce all rights arising under the '488 patent.

30. On information and belief, in violation of 35 U.S.C. § 271(a), T-Mobile infringed, literally and/or under the doctrine of equivalents, claims 1 and 2 of the '488 patent through its use, sale, and offer for sale of the Accused Services.

31. T-Mobile either performed, or directed or controlled third parties' performance of, each limitation of claims 1 and 2 of the '488 patent when any of the Accused Services were used on the T-Mobile LTE network.

32. T-Mobile conditioned participation in T-Mobile's LTE network upon performance of the limitations of claims 1 and 2 of the '488 patent and established the manner and/or timing of that performance.

33. On information and belief, the Accused Services, when used on the T-Mobile LTE network, satisfied all claim limitations of claim 1 of the '488 patent for at least the following reasons.

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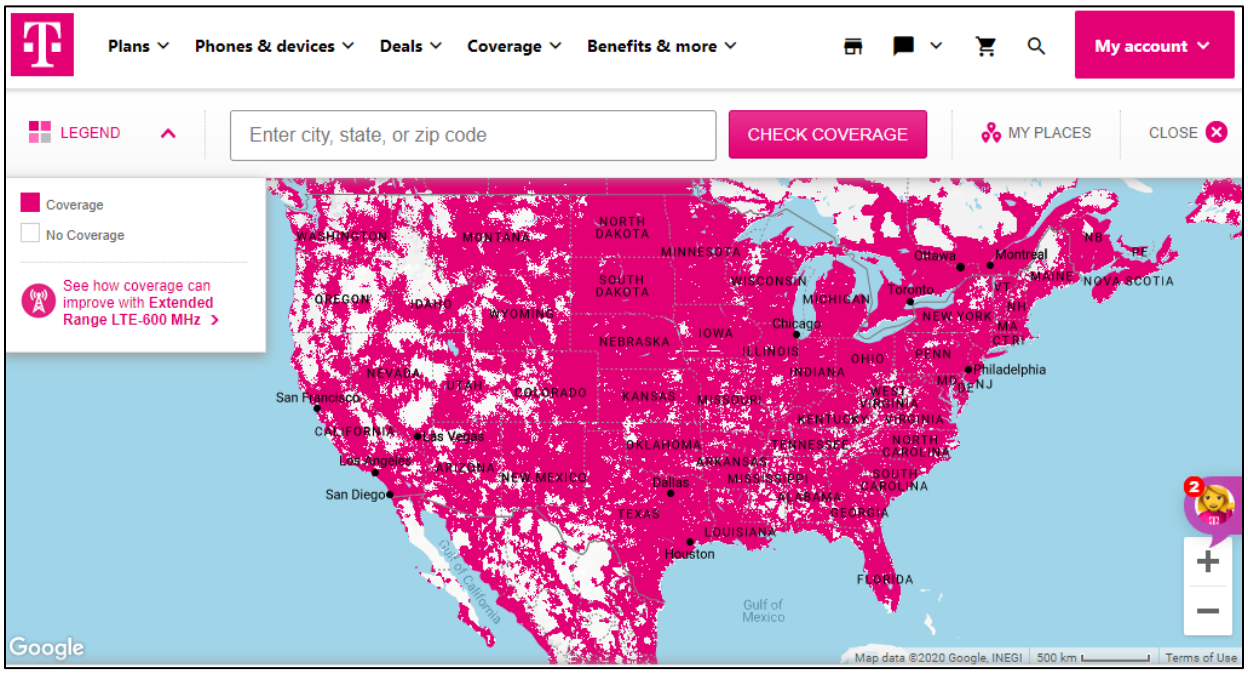
[9] https://www.t-mobile.com/store-locator?sortBy=type2&page=1&search=austin,%20TX; https://www.t-mobile.com/store-locator?sortBy=type2&page=1&search=Waco,%20TX,%20USA

34. The Accused Services enabled a plurality of remote locations to transmit data to a central location.

35. T-Mobile provided LTE coverage that allowed mobile device users to transmit data to a T-Mobile LTE network:[10]




36. The T-Mobile LTE network included LTE base stations, cell sites, and other network infrastructure equipment:[11]

[10] https://www.t-mobile.com/coverage/coverage-map

[11] https://howmobileworks.com/; https://howmobileworks.com/wp-content/uploads/2018/01/tech_choices_2017_v2.pdf; https://howmobileworks.com/faqs-resources/

**We constantly add capacity, coverage and speed to our network: antennas, radios, land-based equipment & more.**

\+

Full Data
& Voice Path

Cell Site

A traditional cell site includes an antenna structure with multiple antennas connected to low powered radio transmitters and receivers. Antennas are usually located 50' to 150' above ground level.

Base Station


Base stations house radio transceivers and amplifiers that provide linkage to the site's antennas and to the high-speed connections (usually fiber optic cable) back to legacy telephone system.

Property Availability


In addition to all the science that goes into properly locating a cell site, T-Mobile must also find a property owner that is willing to have an antenna facility placed on his/her property.

Public and private landlords are compensated for the lease of space where antenna facilities are located – whether on commercial property, local or regional park land, fire or police stations, church property or on an individual landowner's personal property.

## Standard support structures are optimal for meeting customer demand.

A standard wireless facility with antennas mounted on a monopole or other type of tower, is most often the best technology choice based on network design and radio frequency science. These sites typically range from 50' to 150' high and signals can travel up to several miles – depending on geography and topography.

## Versatility for coverage and capacity.

To meet massive customer demand for reliable coverage, T-Mobile® is constantly expanding and upgrading its network technologies and geographic reach.

Why is it necessary for T-Mobile to build a cell site close to my neighborhood?

Our decision to locate a new cell site is based on scientific criteria. In making our decision on where to locate a new site, T-Mobile undertakes a rigorous engineering analysis of available RF signal coverage and future expansion needs.

To choose a potential site, terrain data within the service area is entered into a computer, along with a series of variables, such as proposed antenna height, foliage and building data, population density, available radio frequencies and wireless equipment characteristics. From this information, engineers determine an area for the optimum location and height of the antenna to maximize coverage within the cell.

T-Mobile also looks at different usage patterns of our customers, including the ability to make and hold calls inside buildings and vehicles. Many times a user can make a call on the street, but not be able to make or hold a call as they enter a building. Network data is scientifically measured to determine the amount of traffic at individual cell sites, including the number of dropped and blocked calls. Plus, field technicians, engineers and third-party researchers conduct "drive tests" to collect real-time statistics. These tests simulate the customer experience and provide critical data on signal strength and call clarity.

Can T-Mobile camouflage the site so that it blends in with the trees or the surrounding topography?

T-Mobile works hard to build and modernize the least obtrusive, most technically feasible sites to provide reliable service. When modernizing and upgrading sites, we are most often not changing the structure, but using the same structure while replacing antennas and radio equipment with updated technologies.

When we build a new wireless facility, we try to find existing structures (e.g. industrial, commercial, municipal buildings and structures) before a new freestanding facility is planned. T-Mobile also places a priority on sharing space on an existing carrier's facility before considering building a new facility.

The need to provide reliable wireless coverage to customers often requires that T-Mobile mount antennas on structures that are taller than most of the surrounding structures in an area. For good, reliable communications, the laws of physics mean better coverage when there is an unobstructed line-of-sight radio signal path between a customer's phone and the cell site. This often can only be achieved by installing antennas on tall structures.

T-Mobile works with communities to make antenna and supporting structures visually unobtrusive, but they simply can't be invisible.

37. At each remote location, the Accused Services coded data to be transmitted by translating each group of one or more bits of said data into a transform coefficient.

38. The LTE Standard describes that a compliant customer wireless device produces complex-valued modulation symbols.

39. For example, 3GPP TS 36.211 V10.4.0 (2011-12) Technical Specification (hereinafter, "TS 36.211") at section 7.1 discloses producing "complex-valued modulation symbols":

## 7.1 Modulation mapper

The modulation mapper takes binary digits, 0 or 1, as input and produces complex-valued modulation symbols, $x=I+jQ$, as output.

## 7.1.2 QPSK

In case of QPSK modulation, pairs of bits, $b(i), b(i+1)$, are mapped to complex-valued modulation symbols $x=I+jQ$ according to Table 7.1.2-1.

**Table 7.1.2-1: QPSK modulation mapping.**

| $b(i), b(i+1)$ | $I$ | $Q$ |
|---|---|---|
| 00 | $1/\sqrt{2}$ | $1/\sqrt{2}$ |
| 01 | $1/\sqrt{2}$ | $-1/\sqrt{2}$ |
| 10 | $-1/\sqrt{2}$ | $1/\sqrt{2}$ |
| 11 | $-1/\sqrt{2}$ | $-1/\sqrt{2}$ |

40. In the Accused Services, the transform coefficient was associated with a particular baseband frequency in a particular subset of orthogonal baseband frequencies allocated to the remote location.

41. The LTE Standard describes that each of the complex-valued modulation symbols is assigned to a particular subcarrier frequency.

42. For example, 3GPP TS 36.300 V11.1.0 (2012-03) Technical Specification (hereinafter, "TS 36.300") at section 5.2 describes an Uplink Transmission Scheme:

## 5.2 Uplink Transmission Scheme

### 5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. It also supports multi-cluster assignment of DFTS-OFDM.

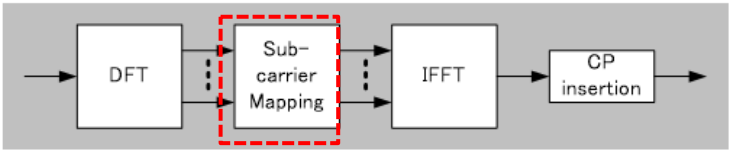



**Figure 5.2.1-1: Transmitter scheme of SC-FDMA**

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, $N_{RB}$, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$ per carrier or per CC in case of CA.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

43. Further, the LTE Standard describes that the particular subcarrier frequency is from a subset of frequencies.

44. For example, 3GPP TS 36.521-1 V10.1.0 (2012-03) Technical Specification (hereinafter, "TS 36.521-1") at Figure 5.4.2-1 describes a channel bandwidth arrangement:

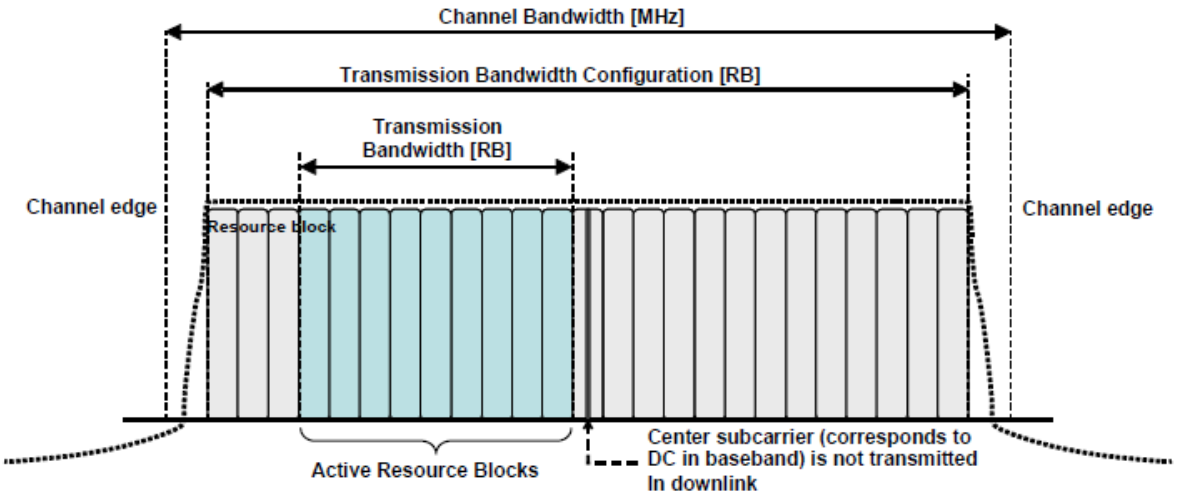
## 5.4.2 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.4.2-1

**Table 5.4.2-1 Transmission bandwidth configuration $N_{RB}$ in E-UTRA channel bandwidths**

| Channel bandwidth $BW_{Channel}$ [MHz] | 1.4 | 3 | 5 | 10 | 15 | 20 |
|---|---|---|---|---|---|---|
| Transmission bandwidth configuration $N_{RB}$ | 6 | 15 | 25 | 50 | 75 | 100 |

Figure 5.4.2-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration ($N_{RB}$). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at $F_C$ +/- $BW_{Channel}$ /2.




45. The particular subset of orthogonal baseband frequencies allocated to each remote location is chosen from a set of orthogonal baseband frequencies, the subsets of baseband frequencies allocated to each remote location being mutually exclusive.

46. For example, TS 36.300 at section 5.2 describes an Uplink Transmission Scheme:

## 5.2 Uplink Transmission Scheme

### 5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. It also supports multi-cluster assignment of DFTS-OFDM.

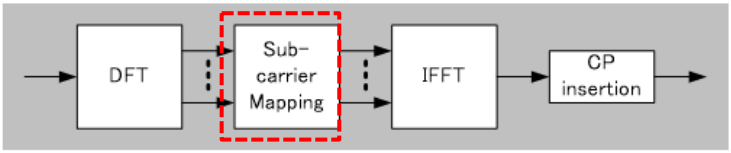



**Figure 5.2.1-1: Transmitter scheme of SC-FDMA**

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, $N_{RB}$, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$ per carrier or per CC in case of CA.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160\times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144\times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512\times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

47. Further, TS 36.211 at section 5.3.4 describes mapping to physical resources:

If uplink frequency-hopping with predefined hopping pattern is enabled, the set of physical resource blocks to be used for transmission in slot $n_s$ is given by the scheduling grant together with a predefined pattern according to

$$\tilde{n}_{PRB}(n_s) = \left(\tilde{n}_{VRB} + f_{hop}(i)\cdot N_{RB}^{sb} + \left(\left(N_{RB}^{sb}-1\right) - 2\left(\tilde{n}_{VRB} \bmod N_{RB}^{sb}\right)\right)\cdot f_m(i)\right) \bmod \left(N_{RB}^{sb}\cdot N_{sb}\right)$$

$$i = \begin{cases} \lfloor n_s/2 \rfloor & \text{inter-subframe hopping} \\ n_s & \text{intra and inter-subframe hopping} \end{cases}$$

$$n_{PRB}(n_s) = \begin{cases} \tilde{n}_{PRB}(n_s) & N_{sb} = 1 \\ \tilde{n}_{PRB}(n_s) + \left\lceil N_{RB}^{HO}/2 \right\rceil & N_{sb} > 1 \end{cases}$$

$$\tilde{n}_{VRB} = \begin{cases} n_{VRB} & N_{sb} = 1 \\ n_{VRB} - \left\lceil N_{RB}^{HO}/2 \right\rceil & N_{sb} > 1 \end{cases}$$

where $n_{VRB}$ is obtained from the scheduling grant as described in Section 8.1 in [4]. The parameter *pusch-HoppingOffset*, $N_{RB}^{HO}$, is provided by higher layers. The size $N_{RB}^{sb}$ of each sub-band is given by,

$$N_{RB}^{sb} = \begin{cases} N_{RB}^{UL} & N_{sb} = 1 \\ \left\lfloor \left(N_{RB}^{UL} - N_{RB}^{HO} - N_{RB}^{HO} \bmod 2\right)/N_{sb} \right\rfloor & N_{sb} > 1 \end{cases}$$

where the number of sub-bands $N_{sb}$ is given by higher layers. The function $f_m(i) \in \{0,1\}$ determines whether mirroring is used or not. The parameter *Hopping-mode* provided by higher layers determines if hopping is 'inter-subframe' or 'intra and inter-subframe'.

48. The Accused Services used, at each remote location, an electronic processor, performing an inverse orthogonal transformation on the transform coefficients to obtain a block of time domain data.

49. The LTE Standard describes that an inverse FFT ("IFFT") is applied to the complex-valued modulation symbols at each consumer wireless device to obtain time domain data.

50. For example, TS 36.300 at section 5.2 describes an Uplink Transmission Scheme:

## 5.2 Uplink Transmission Scheme

### 5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM. It also supports multi-cluster assignment of DFTS-OFDM.

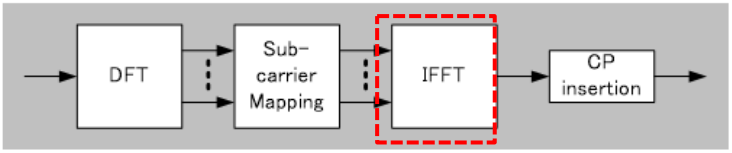



**Figure 5.2.1-1: Transmitter scheme of SC-FDMA**

The uplink sub-carrier spacing $\Delta f = 15$ kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, $N_{RB}$, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$ per carrier or per CC in case of CA.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

51. The Accused Services utilized, at each remote location, a modulator to modulate the block of time domain data onto a carrier signal for transmission to the central location.

52. The LTE Standard describes that each consumer wireless device uses a modulator to modulate the time domain data onto a carrier signal for transmission to the LTE network.

53. For example, TS 36.211 at section 5.8 describes the use of a modulator:

## 5.8 Modulation and upconversion

Modulation and upconversion to the carrier frequency of the complex-valued SC-FDMA baseband signal for each antenna port or the complex-valued PRACH baseband signal is shown in Figure 5.8-1. The filtering required prior to transmission is defined by the requirements in [7].

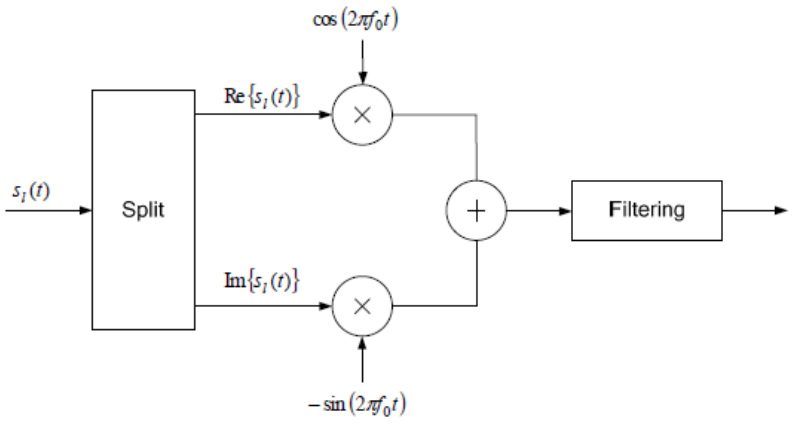



**Figure 5.8-1: Uplink modulation.**

54. In the Accused Services, the carrier signal had the same carrier frequency for each remote location.

55. The LTE Standard describes that the carrier signal used for transmission to the LTE network is a common carrier for each wireless consumer device.

56. For example, TS 36.521-1 at section 5.4.4 describes determining the carrier frequency for each wireless consumer device:

## 5.4.4 Carrier frequency and EARFCN

The carrier frequency in the uplink and downlink is designated by the E-UTRA Absolute Radio Frequency Channel Number (EARFCN) in the range 0 - 65535. The relation between EARFCN and the carrier frequency in MHz for the downlink is given by the following equation, where $F_{DL\_low}$ and $N_{Offs\text{-}DL}$ are given in table 5.4.4-1 and $N_{DL}$ is the downlink EARFCN.

$$F_{DL} = F_{DL\_low} + 0.1(N_{DL} - N_{Offs\text{-}DL})$$

The relation between EARFCN and the carrier frequency in MHz for the uplink is given by the following equation where $F_{UL\_low}$ and $N_{Offs\text{-}UL}$ are given in table 5.4.4-1 and $N_{UL}$ is the uplink EARFCN.

$$F_{UL} = F_{UL\_low} + 0.1(N_{UL} - N_{Offs\text{-}UL})$$

57. The Accused Services employed receiving at the central location from one or more of the remote locations, one or more blocks of time domain data modulated on one or more of the carrier signals.

58. The LTE Standard describes that a given LTE base station receives modulated data from one or more consumer wireless devices via carrier signals.

59. For example, TS 36.211 at section 5.8 describes the use of a modulator by a mobile device for transmission of modulated data to a base station:

## 5.8 Modulation and upconversion

Modulation and upconversion to the carrier frequency of the complex-valued SC-FDMA baseband signal for each antenna port or the complex-valued PRACH baseband signal is shown in Figure 5.8-1. The filtering required prior to transmission is defined by the requirements in [7].

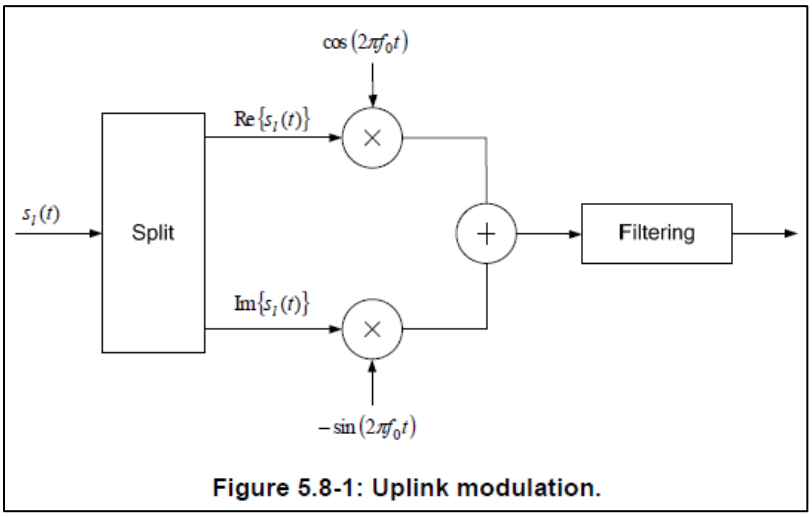



**Figure 5.8-1: Uplink modulation.**

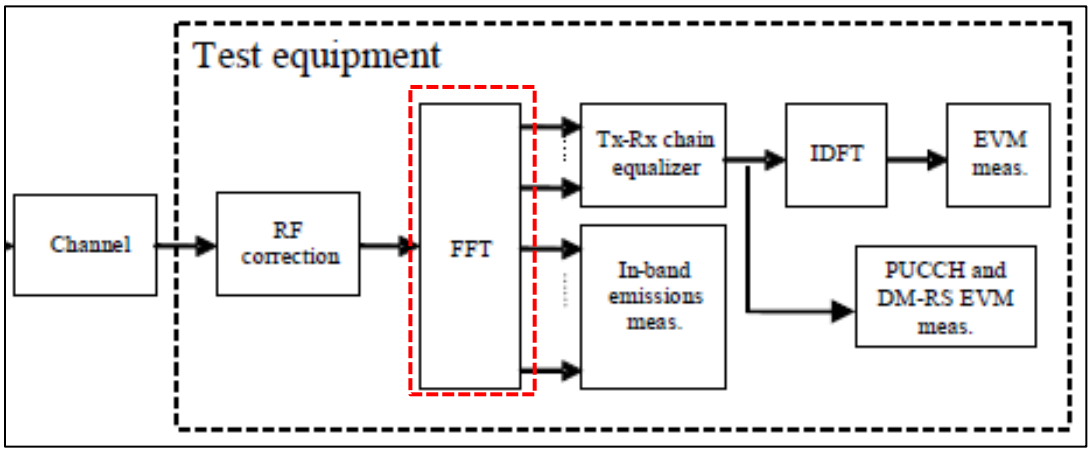
60. The Accused Services used a demodulator, which demodulated one or more blocks of time domain data from the carrier frequency signal.

61. The LTE Standard describes using a demodulator to demodulate time domain data from a carrier.

62. The Accused Services performed the orthogonal transformation on the demodulated time domain data to reconstruct the transform coefficients.

63. The LTE Standard describes performing a FFT to reverse the IFFT described above and construct the complex-valued demodulation symbols.

64. For example, 3GPP TS 36.101 V10.5.0 (2011-12) Technical Specification (hereinafter, "TS 36.101") at section F.1 describes that the LTE network uses FFT:




65. The Accused Services translated the transform coefficients into the data to be translated from each remote location.

66. The LTE Standard describes that the LTE network performs the reverse of the process used to produce the complex-valued modulation symbols.

67. Thus, the LTE Standard describes that the complex-valued modulation symbols are translated into the original data.

68. As described in paragraphs 33-67 above, each limitation of claim 1 of the '488 patent was performed by T-Mobile or otherwise attributable to T-Mobile when any of the Accused Services were used on the T-Mobile LTE network.

69. On information and belief, the Accused Services, when used on the T-Mobile LTE network, satisfied all claim limitations of claim 2 of the '488 patent for at least the following reasons.

70. The Accused Services enabled a plurality of remote locations to transmit data to a central location, as described with respect to claim 1 of the ’488 patent above.

71. At each remote location, the Accused Services coded data to be transmitted by translating each group of one or more bits of the data into a transform coefficient, as described with respect to claim 1 of the ’488 patent above.

72. In the Accused Services, the transform coefficient was associated with a particular baseband frequency in a particular subset of orthogonal baseband frequencies allocated to the remote location, as described with respect to claim 1 of the ’488 patent above.

73. The particular subset of orthogonal baseband frequencies allocated to each remote location was chosen from a set of orthogonal baseband frequencies, the subsets of baseband frequencies allocated to each remote location being mutually exclusive, as described with respect to claim 1 of the ’488 patent above.

74. The Accused Services used, at each remote location, an electronic processor, performing an inverse orthogonal transformation on the transform coefficients to obtain a block of time domain data, as described with respect to claim 1 of the ’488 patent above.

75. The Accused Services utilized, at each remote location, a modulator to modulate the block of time domain data onto a carrier signal for transmission to the central location, as described with respect to claim 1 of the ’488 patent above.

76. In the Accused Services, the carrier signal had the same carrier frequency for each remote location, as described with respect to claim 1 of the ’488 patent above.

77. The Accused Services employed receiving at the central location from one or more of the remote locations, one or more blocks of time domain data modulated on one or more of the carrier signals, as described with respect to claim 1 of the ’488 patent above.

78. The Accused Services used a demodulator, multiplying the received one or more blocks of time domain data with in-phase and quadrature carrier signals to obtain in-phase and quadrature baseband signals, converting the in-phase and quadrature baseband signals to digital form, and using an electronic processor, performing the orthogonal transform using the in-phase and quadrature baseband signals as real and imaginary values, respectively, to demodulate the one or more blocks of time domain data from the carrier frequency signal.

79. The LTE Standard describes modulating a signal using in-phase and quadrature components of the signal.

80. For example, TS 36.211 at section 5.8 describes processing a signal based on its real ("Re") and imaginary ("Im") components:

> ## 5.8 Modulation and upconversion
>
> Modulation and upconversion to the carrier frequency of the complex-valued SC-FDMA baseband signal for each antenna port or the complex-valued PRACH baseband signal is shown in Figure 5.8-1. The filtering required prior to transmission is defined by the requirements in [7].

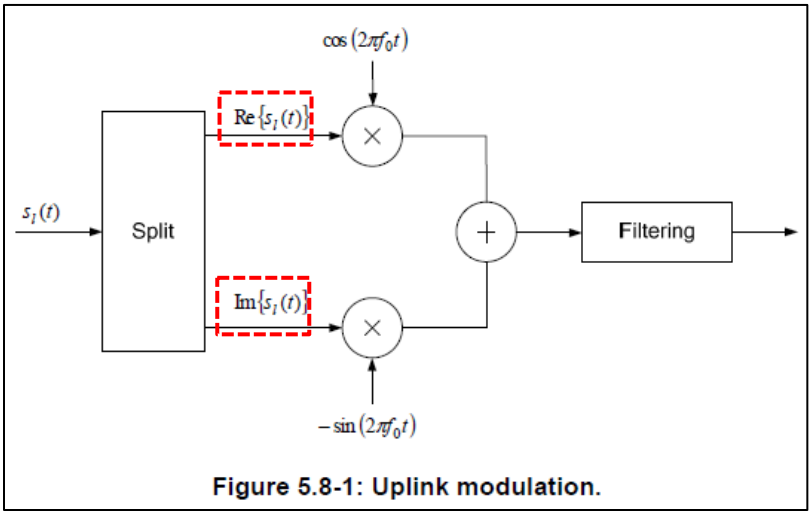



**Figure 5.8-1: Uplink modulation.**

81. Further, the LTE Standard describes using a demodulator to perform the reverse of the modulation described above.

82. The Accused Services performed the orthogonal transformation on the demodulated time domain data to reconstruct the transform coefficients, as described with respect to claim 1 of the ’488 patent above.

83. As described in paragraphs 69-82 above, each limitation of claim 2 of the ’488 patent was performed by T-Mobile or otherwise attributable to T-Mobile when any of the Accused Services were used on the T-Mobile LTE network.

84. TC Technology is entitled to recover from T-Mobile all damages that TC Technology has sustained as a result of T-Mobile’s infringement of the ’488 patent, including without limitation lost profits and no less than a reasonable royalty.

## DEMAND FOR JURY TRIAL

85. Pursuant to Rule 38(b) of the Federal Rules of Civil Procedure, TC Technology respectfully demands a trial by jury on all issues triable by jury.

## PRAYER FOR RELIEF

WHEREFORE, TC Technology respectfully requests that judgment be entered in favor of TC Technology and against T-Mobile as follows:

A. Judgment that T-Mobile has infringed the ’488 patent;

B. Damages sufficient to compensate TC Technology for T-Mobile’s infringement under 35 U.S.C. § 284;

C. Costs and expenses incurred in this action;

D. Prejudgment and post-judgment interest;

E. Attorneys’ fees and costs under 35 U.S.C. § 285; and

F. Such other and further relief as this Court may deem proper and just under the circumstances.

Date: September 30, 2020

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